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ABSTRACT

This study investigates physiological arousal and overt behaviors of hyperactive children in comparison with nonhyperactive children. It was predicted from Farley's (1974) theory of hyperactivity that hyperactive children would exhibit lower arousal and a stronger stimulation-seeking motive than nonhyperactive children. Four measures of hyperactivity were used; arousal was measured by the two-flash threshold and salivary response; two tasks measured the stimulation-seeking motive. Fifty-six second grade students were used in the study: 27 hyperactive, 29 nonhyperactive. The results did not indicate much contribution of arousal to hyperactivity. However, it was argued that the arousal measures, because of their severe attentional requirements, may not be appropriate for comparisons of hyperactive and nonhyperactive children. Recommendations for the more valid measurement of arousal in hyperactive children are made and directions for further testing of the theory outlined. (Author)

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Hyperactivity as a Function of Intrinsic Arousal Level and Stimulation-Seeking[1]

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Hyperactivity as a Function of Intrinsic Arousal Level and Stimulation-Seeking

Abstract

It was predicted from Farley's (1974) theory of hyperactivity that hyperactive children would exhibit lower arousal and a stronger stimulation-seeking motive than nonhyperactive children. Four measures of hyperactivity were used; arousal was measured by the two-flash threshold and salivary response; two tasks measured the stimulation-seeking motive.

The results did not indicate much contribution of arousal to hyperactivity. However, it was argued that the arousal measures, because of their severe attentional requirements, may not be appropriate for comparisons of hyperactive and nonhyperactive children. Recommendations for the more valid measurement of arousal in hyperactive children are made and directions for further testing of the theory outlined.

The purpose of this study was to investigate physiological arousal and overt behaviors of hyperactive children in comparison with nonhyperactive children from the perspective of the motive to seek stimulation. It has been proposed by Farley (1974) that hyperactive children are lower in their intrinsic arousal than normal children and that their stimulation-seeking motive will be strong due to the need to arouse the central nervous system (CNS). It is argued that each individual has a characteristic optimal level of arousal reflected in an inverted U-curve in which the efficiency and quality of behavioral performance will maximize at the peak of the curve, where arousal is moderate. It is further postulated that as the organism deviates from an optimal level of physiological arousal, the goal of some behavior will be to either seek stimulation in the environment or avoid it in order to return to a more optimal state. The relationship between arousal and stimulation-seeking is suggested to be a negative linear correspondence where high states of arousal would predict little behavioral stimulation-seeking, and low arousal states would predict a high degree of behavioral or overt stimulation-seeking (Farley, 1974).

The most explicit available model relating arousal to hyperactivity that includes concrete implications for educationally relevant treatment is that of Farley (1974). Unlike previous arousal analyses such as that of Berlyne (1960) and others, this model explicitly proposes arousal as an individual difference variable (intrinsic arousal). Hyperactivity is held to be a function of under-arousal or hypoarousal in an individual difference sense. The seemingly aimless behavior, fidgetiness, and excitability of the hyperactive child may be intrinsically goal directed behavior. The educationally relevant treatment postulates of a model where hyperactivity is concerned

are divided roughly into three categories: environmental treatment, instructional treatment, and teacher characteristics. It is the purpose of this study to test, in part, Farley's intrinsic arousal/hyperactivity model and its relationship to stimulation-seeking.

The etiological basis of hyperactivity is not well understood. Those who have turned to the measurement of physiological arousal have used such measures as the EEG, heart rate, pulse rate, GSR and SCL, to name a few. None to this date have tried to use measures of cortical resolution such as the two-flash threshold (TFT). That the TFT is a measure of cortical arousal has been demonstrated by Lindsley (1957) and others. The work of Venables and Warwick-Evans (1967) correlated EEG rhythms with the TFT, and Kopell, Noble, and Silverman (1965) studied the effects of stimulant and depressant drugs on the level of the TFT, further validating it as a measure of physiological arousal. The TFT has been used to measure intrinsic arousal level and predict stimulation-seeking behavior of delinquent males (Farley & Astorga, 1974).

The TFT has been found to correlate significantly with autonomic measures of arousal and anxiety, specifically, the SCL and CSC (corrected skin conductance) (Rose, 1966. Maley, 1967). A different (autonomic) measure, a saliva response to lemon juice, has been found to have good test-retest reliability (Farley, Osborne, & Severson, 1971), and has been validated as an index of arousal with the TFT. The TFT and the salivation index have not been used together with a population of hyperactive children.

The research was designed to test specifically the following hypotheses:

1. That hyperactive children will demonstrate lower states of intrinsic arousal than normal children as measured by the two-flash threshold (TFT) and salivary response.

2. Hyperactive children will demonstrate a greater tendency to seek stimulation and sensations as measured by two non-verbal measures: a preference for complex visual forms and a maze task in which many routes are possible. The motive is measured by the number of alternative routes that are chosen.

Method

A total of 56 second grade level school children from two Janesville, Wisconsin elementary schools were used in this study. Any child, or previously diagnosed hyperactive child, was not included if they were in any special education class, if there was known neurological involvement, and if they were taking medication or had been taking it at any time two months prior to the study. Four methods were used for identifying hyperactivity, the first of which was teacher selection. This was a screening device in which teachers were given a description of hyperactivity and were asked to generate a list of hyperactive children from their own classrooms. The teacher was then asked to select control children in the same classroom matched with the hyperactive children on the variables of age, socioeconomic status, academic ability level, and to select children who did not exhibit any hyperactive behaviors or other extremes of behavior. In this manner 27 hyperactive and 29 nonhyperactive subjects were identified and actually used in the study (the discrepancy in N was due to 2 Ss in the hyperactive group not returning their parental permission forms). The second identification procedure involved the completion of the Conners' Behavior Rating Scale by the teachers of the respective students. This scale yields five factor scores: 1. Aggression 2. Inattention 3. Anxiety 4. Hyperactivity and 5. Health. The third identifying measure of hyperactivity was an objective measure in the form of a behavior observation scale developed by O'Leary, Ramanczck, Kass, Dietz, and Santogrossi (1971). Behavior categories were

chosen because of their bearing on potential disruptive qualities in the classroom and for the child. A time sampling procedure was used and each child was observed by two trained independent observers for a ten minute period on two consecutive days during regular classroom lessons with the teacher. The final identification measure used was a star maze task, included as a test of impulsivity (measured by speed of response) and perceptual-motor coordination, measured by the number of errors or contacts with the side of the maze.

Two measures of physiological arousal were obtained, the TFT and net salivation to lemon juice. The TFT is a measure of the threshold of fusion of paired light flashes, where the subject can make the visual discrimination of 2 brief flashes of light from one. Criteria for threshold is established at that point at which 5 msec. separates the report of 1 and 2 flashes of light. This visual discrimination must be repeated twice as evidence that the threshold has been found. While focusing on the light source, subjects placed their heads in a chin rest to attempt to control head movements, and ear phones were worn to control against extraneous noise. The testing rooms in each school were fitted with sound proofing materials. The net salivary response was measured by first taking a baseline level response and then by taking the salivary response to lemon juice.

Two stimulation-seeking measures were obtained from each subject. The first was the preference for 22 random polygons varying in complexity by approximately equal logarithmic steps from 4 to 160 sides and matched in area. Subjects were asked to choose the most preferred polygons. A single score was obtained for this measure, that is a total of the number of sides contained in the top seven choices. The second measure, the pyramid maze, was developed to specifically investigate stimulus-seeking

behaviors, with various and changing routes being possible through a series of five identical mazes. Three indices of stimulation-seeking were derived from this task. It was expected that hyperactives as a group would obtain higher scores on all stimulation-seeking measures than nonhyperactives.

Results

The ability of the selection criteria to differentiate between the teacher identified groups of hyperactive and nonhyperactive subjects was generally not significant. None of the behavior observation categories or star maze measures could significantly differentiate groups. Only three factors on the Conners' Behavior Rating Scale, Aggression, Inattention, and Hyperactivity, resulted in significant t-tests at $p \leq .01$ (one-tailed). In testing the hypothesis that hyperactives are different from nonhyperactive children in their intrinsic arousal and stimulation-seeking motives, the 2 groups were compared on the measures of TFT, net salivation to lemon juice, preference for polygons, and pyramid maze by means of t-tests. No significant differences were obtained between the two groups on these measures. Dunn's procedure was employed in evaluating the statistical significance of all t values.

In addition, intercorrelations among all measures within the hyperactive ($N = 27$) and the nonhyperactive ($N = 29$) groups were computed, with the groups being established on the basis of the teacher's initial identification of subjects. No significant relationships were found within groups on the two arousal measures, nor the two sensation-seeking measures.

In order to extend the analysis further and note which variables were measuring similar attributes, a correlation matrix was computed on 18 variables of the study (subject selection variables, physiological measures and stimulation-seeking measures) and on all 56 Ss. The Pearson correlations ranged

from .00 to +.70. [With a correlation of ±.263 ($p < .05$) taken as significant, there were 25 significant correlations out of 153.]

Of particular interest was the negative correlation between TFT and teacher identification of hyperactive children, which was in a direction opposite to that predicted. Net salivation did not correlate well with any variables and stimulation-seeking variables did not relate linearly with variables other than themselves, except for the number of individual routes taken on the pyramid maze, which was negatively correlated with the TFT, again not in the predicted direction. Overall, teacher identification was significantly related to more variables than was any other measure.

Discussion

As stated previously, most of the subject selection variables did not corroborate the delineation of hyperactive and nonhyperactive groups set forth initially by the teachers. Only three factor scores on the Conners' Behavior Rating Scale, Aggression, Inattention, and Hyperactivity remained significant. A possible explanation for this lack of difference between groups in the quantity of behavior observed is that differences in quality and intensity of behavior exist which the teachers are responding to, and which are not reflected in the behavior observations. The only indication of qualitative differences between groups in this study comes from the finding of more significant correlations within the nonhyperactive group on identifying variables, indicating they may have a more homogeneous or comparable set of traits than the hyperactive children; and that the hyperactive group is a more complex composite of behavior as evident in the lack of interrelatedness among these same variables.

The results found do not support either of the hypotheses tested. The extremely low correlations between net salivation and the other variables is partially understood in light of the rigid conditions under which the

test must be conducted. This study did not find any trend, positive or negative, from the measurement of net salivation that could categorize adequately groups in terms of high or low levels of arousal.

The results on the TFT indicate that hyperactive children have a non-significantly higher state of intrinsic arousal (lower TFT scores) than normal children. The results on the TFT are difficult to interpret in that this measure has not been used with this age group before. One interpretation could focus on the task required by the TFT and the nature of the visual system. While obtaining a threshold it is important that the subject maintain a rigid and fixed attention to the point of source of light for valid measurement. This is partially accomplished with the chin rest, however head movements and shifts in visual attention are still possible. It is possible that the attentional problems frequently characterized among hyperactives may carry over to measurement on the TFT. Thus, if the hyperactive child is looking away from the light source his/her visual system would be less likely to habituate to sensory stimulation and would be able to make finer temporal discriminations of the paired light signals giving them a higher level of measured arousal. If the nonhyperactive children are continuously fixated on the light source, their visual system may habituate to the flashes, shifting their threshold in an upward direction that would indicate a low level of arousal. These attentional processes would therefore interfere with the estimate of true arousal level in the children. This is just one possible explanation for the results, and a possible solution would be to measure arousal level in a way that would not be affected by, or could take into account extraneous movements by the child. More peripheral measures, such as GSR, heart and pulse rate, or SCL and SPL may be appropriate.

Another explanation of the results found on the TFT takes into account effects of environmental factors. Satterfield et. al. (1974) found that the Skin Conductance level of MBD children may be over dependent upon environmental factors such that they would be under-aroused in situations with minimal stimulation, and over-aroused in situations with high levels of stimulation.

The original hypothesis of this study stated that hyperactive children are chronically under-aroused. If in addition, this population finds environmental stimuli more arousing it is conceivable that the conditions of testing on the physiological measures were highly arousing to all subjects. Actual room dimensions were small and the experimenter was unknown to the subjects. The differential response to the experimental conditions between groups would have to be explained as an oversensitivity among the hyperactive subjects in the direction of over-arousal to the environment. Any causal statements, however, about the results must remain speculative.

The second hypothesis relating high levels of stimulation seeking to hyperactivity and to low levels of arousal was not upheld by this study. One interesting result, however, was the significant positive correlations of pyramid change scores with total observed behavior. This is perhaps the only evidence in the present study suggesting a stronger stimulation-seeking motive among hyperactive children. Nonetheless, the stimulation-seeking variables did not differentiate the teacher nominated groups in this study and the lack of variance on scores restricts the classification of subjects on this dimension. Further, the motive as it was measured and its relationship to actual behavior in children of this age is not clearly known at this time.

The scientific importance of the study lies in its attempt to identify physiological bases for a complex human problem, and to integrate work

on hyperactivity into a theoretical/conceptual framework. The educational value lies in the potential for providing alternative, early, and simple identification of hyperactive children. That arousal may have an important part in the learning process has already been shown (Farley, 1970). Further, investigations of arousal level coupled with an understanding of hyperactive childrens' stimulation-seeking needs, may provide new information on the treatment of such children, if it can be shown to be a significant factor in hyperactivity.

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